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EARLY NEOLITHIC BURIALS FROM GRUMĂZEŞTI – *DELENI*, NEAMŢ COUNTY, ROMANIA

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***Keywords**: Early Neolithic, Romania, burial, ^{14}C, stable isotopes*
***Abstract:** Human skeletal remains of at least three individuals were unearthed during excavations at the Early Neolithic site of Grumăzeşti – Deleni in northeast Romania (Moldova region) between 1968 and 1978. They comprise the articulated skeleton of an adult buried in a crouched position (M1), and the disarticulated remains of another adult and a juvenile found together in another part of the site and interpreted by the principal excavator, S. Marinescu-Bîlcu, as a disturbed burial (referred to here as M2/1–2). The human remains are described and analysed in terms of state of preservation, age-at-death, sex, stature and pathology. Results of radiocarbon dating and carbon and nitrogen stable isotope analysis of bone collagen from M1 and radiocarbon dates on herbivore bones from the site are presented and discussed.*

***Cuvinte-cheie**: neolitic timpuriu, România, mormânt, ^{14}C, izotopi stabili*
***Rezumat:** Cercetările arheologice din situl de la Grumăzeşti – Deleni din nordul României, realizate între 1968 și 1978, au pus în evidența existența unor resturi osteologice umane de la cel puțin trei indivizi. Primul dintre aceștia, M1, era reprezentat de un schelet în conexiune anatomică, descoperit în poziția chircit pe partea stângă. Resturile fragmentare atribuite altor doi indivizi (denumite în acest articol M2/1–2, un adult și un juvenil) provin dintr-un context diferit, fiind interpretate de autorul cercetării arheologice, S. Marinescu-Bîlcu drept un mormânt deranjat de o amenajare ulterioară. Lucrarea de față face o analiză descriptivă a stării de conservare a resturilor osteologice, determinarea vârstei, sexului și staturii, precum și a patologiilor identificate pe resturile osteologice prezente. Analiza antropologică este însoțită de o discuție asupra datelor de radiocarbon realizate pe probe prelevate de la M1 și două erbivore de talie mare. Pentru M1 au fost realizat și studiului izotopilor stabili de C și N.*

INTRODUCTION

The Early Neolithic site of Grumăzeşti – *Deleni* (Neamț County, 47°09'19" N, 26°24'42" E, Fig. 1) was discovered by Silvia Marinescu-Bîlcu in 1966, while excavating the nearby Cucuteni settlement at Târpești. Five excavation seasons were conducted by Silvia Marinescu Bîlcu and Alexandra Bolomey in 1968, 1971, 1972, 1977 and 1978. Twenty trenches (*secţiune*) with a combined area of 323 m^2 were excavated. The results of the excavations were presented in a series of publications, the most important being those by Marinescu-Bîlcu (1975; 1993) and Boroneanţ (2012). Cultural remains belonging to the Early Neolithic (Starčevo-Criş culture), Middle Bronze Age (Komariv and Noua cultures) and the Migration Period (3rd and 4th centuries AD) were uncovered. Early Neolithic features and finds were recorded more or less across the entire area investigated, while Bronze Age finds were concentrated in the southern part of the site. The following stratigraphic sequence was reported by Boroneant (2012):

1. Surface vegetal soil with a maximum thickness of 30 cm, heavily affected by agriculture, and with mixed archaeological finds;
2. Dark brown soil with very few finds, mostly dating to the 3rd and 4th centuries AD;
3. Light brown soil containing mainly Early Neolithic and some Noua culture finds;
4. Yellow clayey soil, archaeologically sterile.

Subsequent investigations of Grumăzeşti – *Deleni* have been concerned with establishing the spatial extent of the site by means of archaeological and geomagnetic surveys (Diaconu 2012) and the provenance of obsidian used for making chipped stone artefacts (Boroneanţ *et alii* 2018).

The Early Neolithic finds comprise large quantities of pottery, chipped and polished stone tools, a few ground stone tools, rare osseous tools, charcoal (collected for ^{14}C dating) and Early Neolithic human remains[1]. Thirteen features were associated with the Early Neolithic (Fig. 2): six (L1, L2, L3, G6, F1, F2) were likely dwelling structures, three (F21, F25, F26) were considered to be pit features, one (F24) was interpreted as a lithic workshop, and one (F6) is of uncertain function (see below). A formal human burial (M1) was uncovered in Trench IV, while remains of a possible second human burial (M2) were observed in Trench II.

[1] Most of the Grumăzești archaeological material is now in the storage facilities of the "Vasile Pârvan" Institute of Archaeology in Bucharest.

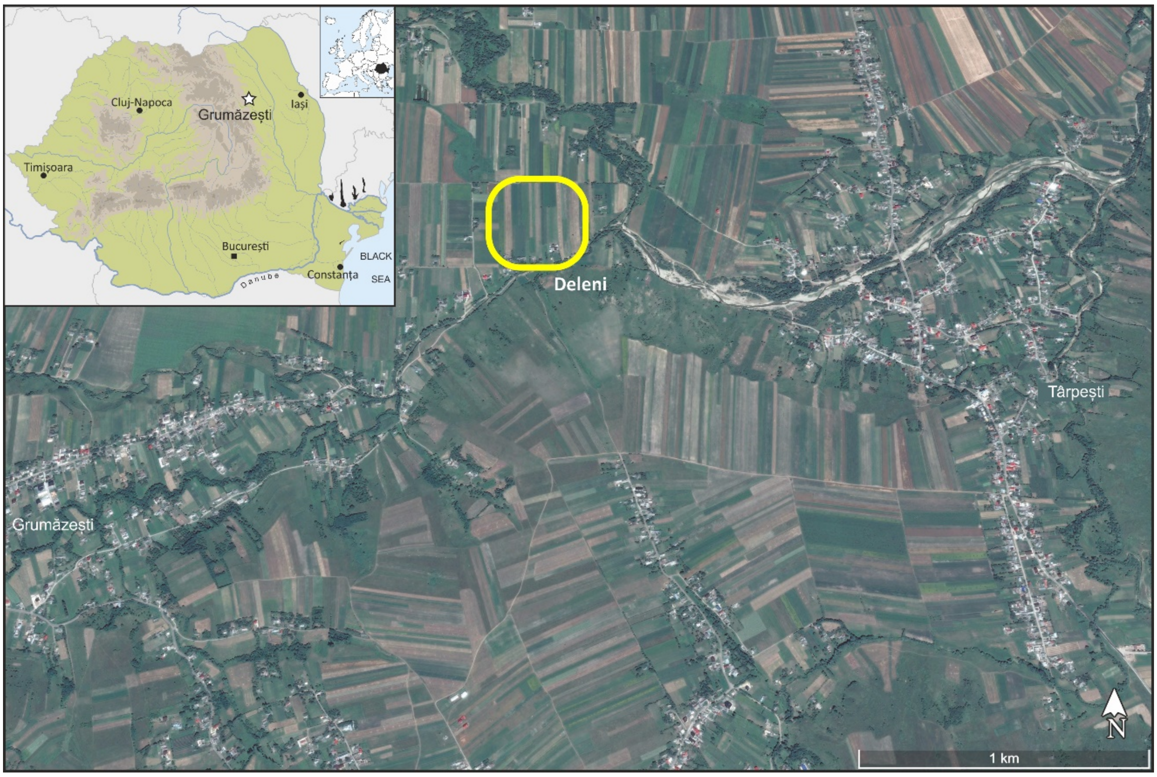

Figure 1. *Location of the Grumăzești – Deleni site. Google Earth imagery 21/10/2017 (accessed 14/03/2018).*

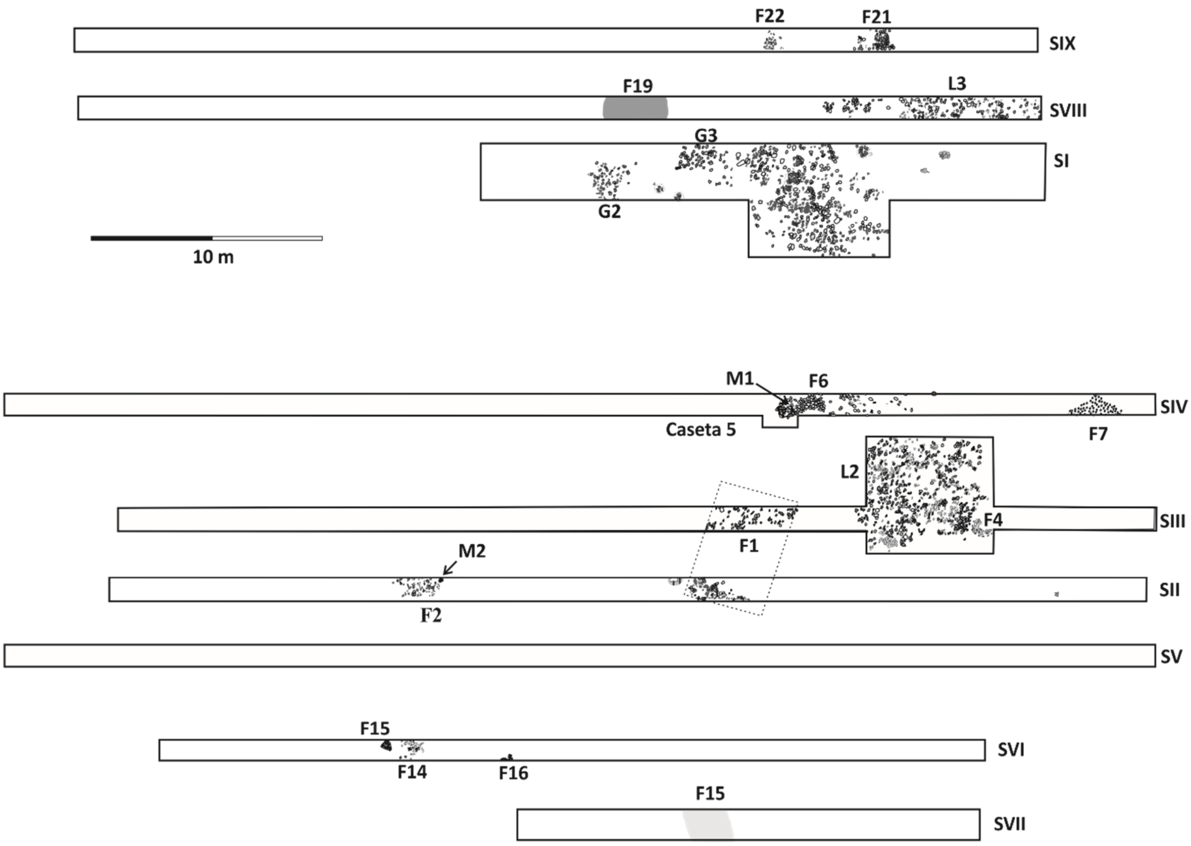

Figure 2. *Grumăzești – Deleni 1968–1978: A. Plan of trenches showing the principal archaeological features (after Boroneanț 2012).*

THE BURIALS

Burial M1 occurred at a depth of 0.85–0.88 m (Fig. 3) and a small extension to Trench IV (*Caseta 5*) was excavated to expose the entire skeleton, which was lying on the left side, with arms flexed and the hands placed under the skull. The legs were also tightly flexed. The orientation of the burial was W–E. There were no associated finds (grave goods) and the outline of the grave pit could not be recognized. According to the excavators, the skeleton was in a poor state of preservation, with the limb bones fractured, partial preservation of ribs and pelvic bones, and the skull broken.

The skeleton was partially overlain by an agglomeration of stones, pottery sherds and bones (F6), described in the field notes as the remains of a dwelling. The excavators made no direct connection between this structure and the skeleton. However, comparison of the respective ground plans indicates that F6 was directly above the skeleton (Fig. 4) leading one of us (A. Boroneanţ) to suggest that the feature may have been intended to seal the grave (Boroneanţ 2012).

A fragmented human skull (M2) and what in the field notes are described as "other human and animal bones, pottery and daub fragments, and stones" were uncovered in Trench II, squares 17 and 18 at a depth of 1.20–1.40m. This feature (F2, Boroneanț 2012) was interpreted by the excavators as the remains of a (surface?) dwelling that had disturbed a burial. The south profile of Trench II appears to show F2 as part of the Early Neolithic occupation horizon, rather than a distinct feature (Fig. 5).

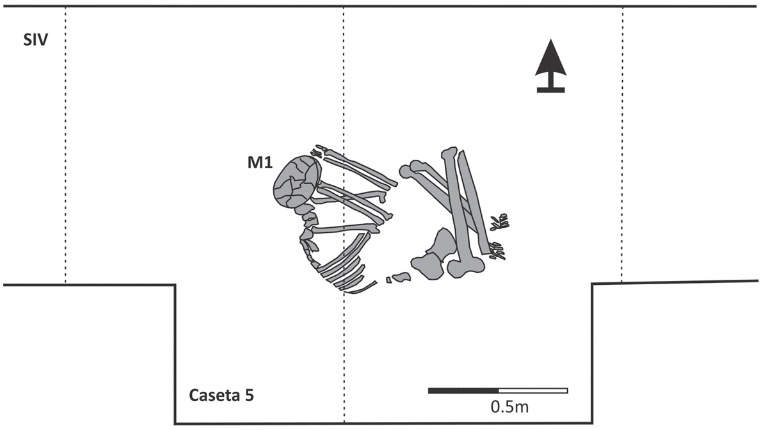

***Figure 3**. Burial M1 (after Boroneanț 2012).*

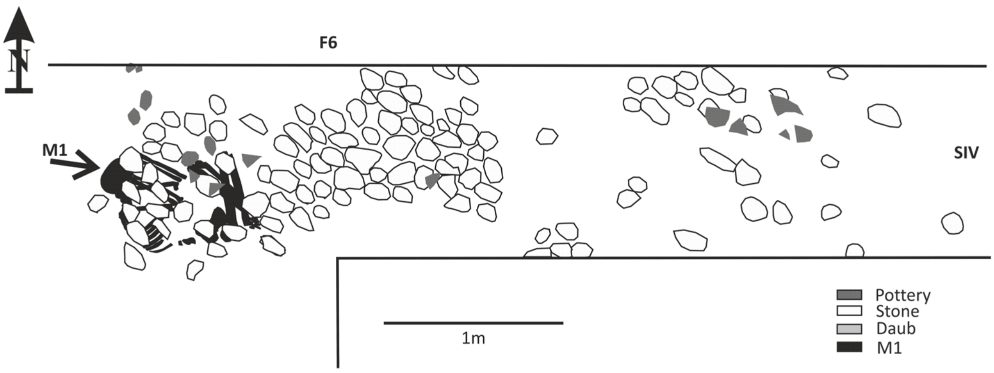

***Figure 4.** Position of M1 in relation to feature F6 (after Boroneanț 2012).*

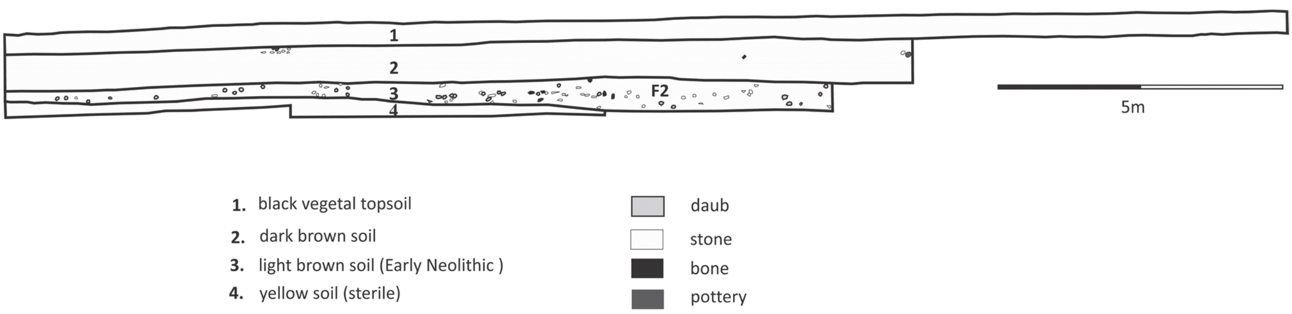

***Figure 5**. Southern section of Trench II (after Boroneanț 2012).*

ANTHROPOLOGICAL ANALYSIS

Materials and methods

Osteological analysis of M1 and the human skeletal remains identified as M2 was undertaken, bearing in mind two limiting factors: 1) their degree of fragmentation and other forms of taphonomic damage, in particular weathering of the cortical bone, and 2) the fact that commonly used standards for determining age and sex are generally based on modern populations and must therefore be employed with caution when examining prehistoric remains.

Measurements to the nearest millimetre were taken on complete or reconstructed bones, using a vernier caliper, osteometric board and measuring tape, following the guidelines of Buikstra and Ubelaker (1994) and Bass (2005). Given their high degree of fragmentation, the cranial vault, mandible, pelvic bones and all long bones had to be temporarily reconstructed using acid-free paper tape to facilitate observations and measurements. Estimation of sex and age, and assessment of pathological and/or anomalous lesions were carried out according to standard criteria, referenced in the following sections. A descriptive approach has been adopted in this paper; detailed metrical and comparative analyses will be presented in a later publication.

State of preservation and inventory

The surviving cranial and postcranial bones of M1 represent approximately 70% of the entire skeleton and could be laid out anatomically in the lab. Thus, by number of bones present, a score between 2 and 3 (where 1 = poor; 2 = fair; 3 = good; 4 = excellent) could be assigned to this skeleton. However, while the cortical bone was generally in a good state of preservation, the degree of fragmentation was high with more than 50 very small (< 1 cm) fragments present (which for the most part could only be identified to skeletal area rather than specific bones), and a further 15 skull fragments. Nevertheless, the cranial vault, upper limbs and right lower limb could be partially reconstructed.

The cranial vault was represented by fragmented parietal, temporal, frontal and occipital bones. The sphenoid and other facial/endocranial bones consisted of very small fragments. The central body and a fragment of the left mandibular ramus at gonion and two fragments of the maxilla, with associated upper and lower dentition, were also identified. Of the upper dentition, all incisors, both canines and first premolars, right second premolar and right first molar were present, while the left second premolar had been lost antemortem. The mandibular dentition was almost complete, and only the right second molar was lost postmortem and not recovered.

The upper limbs were in a good state of preservation. Both humeri were almost completely reconstructed – the left, however, had lost its proximal end. Both radii and the left ulna were missing their distal ends, while the right ulna was reconstructed completely. The right hand was in a good state of preservation with some carpals (scaphoid, lunate, triquetral, trapezoid and capitate), all metacarpals, and four proximal and possibly three intermediate phalanges present. The left hand was represented by carpals (scaphoid, lunate, trapezium, capitate and hamate), two fragmented metacarpals and one proximal phalanx. Two un-sided distal phalanges were also retrieved. The bones of the shoulder girdle, thorax and vertebrae were poorly preserved. Both clavicles lacked their medial end. The scapulae were represented only by the glenoid cavities and fragmentary spines. There were six fragments of (probably) right ribs, one fragment of a left rib, and numerous un-sided rib shaft fragments. Fragments of the atlas and axis vertebrae were identified, but the rest of the spine was represented by a few fragments of cervical and lumbar bodies and neural arches only. Surprisingly, the superior part of the coccyx was also recovered. The pelvic girdle was represented by damaged ilia and ischia, of which 50% was present, including the auricular surface of the ilium and greater sciatic notch. The lower limbs included the complete reconstructed right femur, the proximal two-thirds of the left femur and a fragment of its distal end, fragmentary and partially reconstructed right and left tibiae and fibulae, and relatively well-preserved feet comprising right and left calcanei and talii, some tarsals (the right cuboid and the left navicular and first cuneiform), three right and four left metatarsals, and one proximal, three middle and one distal phalanges (un-sided).

From M2, the fragmented remains of at least one adult (M2/1) and one juvenile (M2/2) were recovered. The adult femur was broken into four pieces: the proximal end, proximal third of the shaft, the midshaft, and distal third. Unfortunately, the greater and lesser trochanters were missing. The other bone fragments, probably all from the same individual, included 13 cranial fragments of parietals and/or frontal bones (some of them reconstructed with non-water-soluble glue), one right orbital margin fragment, one fragment of the left distal humerus, and one complete left ulna.

Estimation of sex, age and stature

The pelvis of M1 displayed a wide greater sciatic notch which, however, curved internally suggesting a male individual (Phenice 1969; Walker 2005). Unfortunately, both pubic symphyses and the sacrum were missing, thus the shape of the complete pelvis could not be assessed for sex attribution. The cranium exhibited large mastoid processes, a prominent nuchal crest, a sloping forehead and thick orbital margins. The mandible displayed a square chin and moderate flaring of the mandibular ramus at gonion. Postcranial measurements (Bass 2005) indicate possible male or indeterminate sex. Furthermore, this individual's measurements fit within the general values provided for male individuals from Romanian Neo-Eneolithic sites (Table 1). Thus, M1 can be identified as probably male.

For assessment of age, in addition to the observation that all preserved epiphyses were fused and the third molars had erupted, only scoring methods for dental attrition and auricular surface morphology could be used. The former suggested an age of 25–35 years using Brothwell's (1989) scoring system; the latter 35–39 years using Lovejoy's method (Lovejoy *et alii* 1985), and 25–50 years with the Buckberry and Chamberlain scoring method (Buckberry, Chamberlain 2002). A fragment of the sacrum (S1) displayed probable lack of fusion between the sacral bodies of S1 and S2 (Schaefer *et alii* 2009). Hence, age-at-death can probably be placed in the late 20s to early 30s, but not much older.

Stature was calculated from the reconstructed right femur by means of regression equations based on modern and contemporary populations (Trotter, Gleser 1952) with a value of 162.80 ± 3.27 cm. However, the maximum length of the femur was preferred for direct comparison with that of other Neolithic adult males reported in the archaeological literature (Table 1).

Id.	Site	Period	Burial	Estimated age (years)	Estimated sex	Cranium Max Length	Humerus Max Length	Femur Max Length	Reference
1	**Grumăzești – *Deleni***	Early Neolithic	M1	25–30	Male	*200	310	426	Present paper
2	**Sf. Gheorghe – *Bedeháza***	Early Neolithic		55–60	Female	185			Russu, Mareş 1956
3	**Ocna Sibiului – *Fața Vacii***	Early Neolithic		Adult	Female	186	278	400	Paul, Cristescu 1963
4	**Gura Baciului**	Early Neolithic		20–25	Female	170			Necrasov 1965
5	**Solca**	Early Neolithic		50–55	Male	193			Necrasov 1965
6	**Boian**	Late Neolithic			Female	185	297	399	Haas *et alii* 1959
7	**Fărcaşele**	Late Neolithic	S1	21–26	Male	186	286	404	Wolski, Nicolaescu-Plopșor 1970
			S2	23–29	Female		270	388	
8	**Cernavodă – *Dealul Sofia***	Eneolithic			Male	190**			Necrasov *et alii* 1965
					Female	185**			
9	**Valea Lupului**	Eneolithic	VL10	25–30	Male	180			Antoniu, Rosca-Gramatopol 1966
			VL16	30	Male	196			
			VL18	30	Male	182			
			VL21	25–30	Male	186	338	488	
			VL22	35	Male	206		473	
10	**Târpeşti**	Eneolithic	M1	30–35	Female	184	283	403	Nicolăescu-Plopșor 1964
			M2	25–35	Male	209	315	450	
			M3	17–20	Female	181			
11	**Sultana – *Malu Roşu***	Eneolithic	M3	40	Female			390	Ion, Soficaru 2008
			M4	45–55	Female			380	
			M7	30–35	Male			460	
			M8	35–40	Female		290	400	
			M10	35–40	Female			370	
			M12	35–40	Male		320		
*Approximate value ** Average values from all burials									

Table 1. *Metrical data (in mm) from case studies from the Romanian Neo-Eneolithic, including maximum length of the cranium, and maximum length of the humerus and femur.*

M2 included bones of an adult – M2/1 (femur) and a juvenile – M2/2 (cranial and upper limb fragments). The left femur could belong to a young adult given the thick cortical bone but not particularly strong muscle and ligament attachments. Furthermore, the fusion line was still slightly visible at the proximal epiphysis; the degree of fragmentation did not allow measurement of the maximum length. If we were to estimate this individual's sex only from the surviving femur, diagnostic features based on modern populations would indicate indeterminate sex.

The juvenile (M2/2) remains belonged to a full-term foetus or infant, and included skull and arm fragments, probably from the same individual. From the maximum length of the ulna (549 mm) the age could be estimated as between 35.6 and 40 gestational weeks using reference standards derived from European modern foetuses (Fazekas, Kósa 1978; Scheuer *et alii* 1980; Jeanty 1983).

Skeletal changes and pathology

M1 displayed a number of antemortem lesions, including pathological and entheseal (muscle-ligament attachment site) changes. In the skull, the most prominent pathological lesions affected the dentition and alveolar bone. While the molars showed minimal attrition, the upper and lower anterior teeth presented moderate to severe wear with dentine exposure, particularly the maxillary left first and second incisors and left canine, the crowns of which were almost completely lost to attrition. Both the mandibular and maxillary dentition were affected by calculus (which had been largely lost postmortem) and periodontal disease (Fig. 6), indicated by recession and porosity of the alveolar margins (Ortner 2003). The mandible also showed new bone formation at the buccal aspect of the second and third molars. In the maxilla, the right first molar exhibited a carious lesion at the mesial interproximal surface, and a periapical lesion was present at the root (Fig. 7). The left second premolar had been lost antemortem.

Figure 6. *M1 - Mandibular teeth showing root exposure, porous alveolar bone and remnants of calculus depositions.*

Figure 7. *M1 – Maxillary right upper first molar displaying a carious lesion (white arow), light-brown mineralised deposits of supra-gingival calculus, and a periapical lesion (black arrow).*

The occipital protuberance, superior nuchal line and occipital crest, to which the muscles and ligaments allowing extension and rotation of the head attach, were prominent and sharp. In the upper limbs, both humeri showed stress-induced lesions in the area where the insertions of *m. brachialis major* and *m. deltoid major* and the origin of *m. triceps brachii* overlap (Fig. 8). The right ulna exhibited thickening and remodelling of the cortical bone of the distal shaft, at the level of the pronator ridge, to which the *m. pronator quadratus*, allowing the hand and forearm to pronate, attaches (Fig. 9). This is suggestive of an old, well-healed injury, perhaps a parry fracture of the distal end (Lovell 1997, p. 161; Judd 2004, p. 41). However, this cannot be verified without x-raying the bone, since the same changes could be associated with musculo-ligamentous activity and given that the associated radius lacked its distal end. In the lower limbs, the only significant changes were the presence of enthesopathies on both calcanei at the Achilles tendon insertions.

No significant features were observed on the remains from M2 except for possible gnaw-marks on the cortical surface of the femoral midshaft from M2/1. Furthermore, given the previous use of glue to reconstruct the femur, it is difficult to establish whether breakage was peri- or postmortem.

Figure 8. *M1 – deep, remodelled sulcus at the muscle attachment site on the proximal end of both humeri.*

Figure 9. *M1 – possible bony callus on the distal end of the right ulna (scale in cm).*

Figure 10. *M2/1 – gnaw-marks on the cortical surface of the femoral midshaft.*

RADIOCARBON DATING AND STABLE ISOTOPE ANALYSES

Materials and methods

Two samples of mammalian (herbivore) bone and a fragment of human bone from the left ulna of M1 were selected for AMS ^{14}C dating. Since the faunal material from archaeological features near to M1 (including the investigated part of F6) was generally poorly preserved and frequently unidentifiable, the two herbivore bone samples came from F21 in Trench VIII, sq. 9–10 – a large, roughly circular pit (diameter ca. 3 m), which was first observed at a depth of 0.90 m and extended down to ca. 1.75 m. From the infill of F21 were recovered numerous Early Neolithic pottery sherds, animal and human bones, daub fragments, ash, charcoal and stone, flint and obsidian artefacts. Some daub fragments displayed thick (5–7 cm diameter) wattle imprints.

The human and animal bone samples were dated at the Accelerator Mass Spectrometry Center at "Horia Hulubei" National Institute for R&D in Physics and Nuclear Engineering, Bucharest, using the Center's standard sample pre-treatment protocol for bone, whereby individual samples are cleaned, rinsed in ultrapure water, dried to constant mass, then ground to a coarse (1–2 mm) powder. Collagen extraction is performed using an AA + ultrafiltration pre-treatment, followed by lyophilization (for details, see Sava *et alii* 2019). Carbon and nitrogen stable isotope ratio analyses on excess collagen from the ^{14}C dating of M1 were carried out at the Scottish Universities Environmental Research Centre, East Kilbride, UK, as described in Sayle *et alii* (2013). No excess collagen from the herbivore bone samples was available for stable isotope analysis.

Results

The results of the ^{14}C and stable isotope analyses are presented in Table 2. Radiocarbon calibrations were performed using OxCal v 4.3.2 (Bronk Ramsey 2017) and the IntCal13 dataset (Reimer *et alii* 2013).

Lab ID	**Sample details**	**Context**	**^{14}C age BP**	**δ^{13}C (‰)**	**δ^{15}N (‰)**	**C/N**	**Calibrated age (95% confidence)**
RoAMS: 729.6	*Bos taurus*, maxilla	F21, Trench VIII, sq. 9–10	6756 ± 40				5726–5619 cal BC
RoAMS: 729.5	*Cervus elaphus*, metacarpal	F21, Trench VIII, sq. 9–10, -1.75	6561 ± 41				5615–5472 cal BC
RoAMS: 729.7	*Homo sapiens*, ulna	M1, Trench IV, sq. 17–18, -1.20-1.40	6474 ± 47	-20.0	11.1	3.3	5517–5338 cal BC

Table 2. *AMS radiocarbon dates and stable carbon and nitrogen isotope data from Grumăzești – Deleni.*

DISCUSSION

Human skeletal remains

Although it is difficult and potentially unsafe to make generalizations about such a limited sample of human remains, burials and their contexts can sometimes yield valuable biocultural information.

Previous studies of the Early Neolithic in the territory of Romania have shown that burials are few in number and unevenly distributed. Published accounts of skeletal remains from Neolithic burials between 1960 and 1990 focused mainly on morphological and anthropometric observations (e.g. Nicolăescu-Plopşor 1966) but also showed an early interest in the interpretation of demographic and palaeopathological data against the background of archaeological, cultural and environmental evidence (Necrasov, Cristescu 1967; Necrasov 1985; 1988). Publications reporting meticulously measured skeletal remains are extremely useful for comparative purposes and have facilitated the assessment of biological sex for adult individuals from contexts M1 and M2.

The individual from M1 showed skeletal changes that could be linked with lifestyle. The degree of attrition observed on the anterior dentition, especially the incisors, may have been the result of a repetitive action (*e.g*. use of teeth as tools), often encountered in prehistoric populations (Ortner 2003, p. 605). A coarse, unrefined diet, however, may also have contributed to the wear pattern. Furthermore, although case studies from the Romanian Early Neolithic generally report evidence of a 'healthy dentition' (Necrasov, Cristescu 1967, p. 168), this individual displayed a few dental lesions. A carious cavity of the right maxillary first molar crown had resulted in the infection of the associated alveolar bone as shown by the presence of a remodelled cyst around the root (Hillson 2005, p. 307); the same tooth also exhibited dental calculus. Moreover, the left maxillary second premolar was lost antemortem, as evidenced by remodelling of the alveolar bone. These lesions, together with generalised alveolar bone resorption and root exposure indicative of inflammation of the gums, could have been caused by specific dietary habits. The caries exhibited by the individual from M1 was not associated with severe attrition (which can lead to cavities) but was more likely a consequence of diet and poor oral hygiene.

The bony changes observed on the skeleton from M1 could be an adaptation to specific activity, although the fact that males generally display more prominent muscle attachments must also be taken into account. The deep, remodelled sulcus for the insertion and origin of muscles and tendons that enable movement and elevation of the shoulder, and extension and abduction of the forearm, observed on both humeri, might point toward a repeated action. Similarly, specific muscular actions may have led to the formation of the changes observed on the occipital, in particular 'carrying loads with the arms straight along the side of the trunk' (Capasso *et alii* 1999, p. 12). The bilaterality and location of these lesions support their aetiology from a repeated action.

Human remains from context M2 comprise the fragmented bones of at least two individuals, perhaps from a disturbed burial or burials. Little more can be said given the extremely limited information available from both osteological analysis and the archaeological context.

Radiocarbon and stable isotope analyses

The Grumăzeşti – *Deleni* site is situated in the region of Moldova (NE Romania), which occupies an area of ca. 46,000 km^2 between the Eastern Carpathians and the River Prut (Fig. 1). The Neolithic in this region has been divided recently into two main phases, Neolithic I (Starčevo-Criş, ca. 6000–5300 cal BC) and Neolithic II (LBK, ca. 5300–5000 cal BC) (Brigand, Weller 2018).

The very limited number of ^{14}C and stable isotope analyses undertaken for this paper were aimed at refining the chronology of the Early Neolithic (Starčevo-Criş culture) occupation at Grumăzeşti – *Deleni* and establishing the position of burial M1 in the Starčevo-Criş occupation sequence. Two samples of herbivore bone were dated from context F21 (Table 2, Fig. 11). According to the excavators' field notes, the pottery from this pit feature displayed Vinča-like shapes indicative of a late phase of the Starčevo-Criş culture (carinated bowls with protruberances on the maximum diameter line) but also classical Starčevo-Criş decorative motifs. No painted pottery was recovered from F21.

The dates obtained from the two herbivore bones (Table 2, RoAMS-729.6, RoAMS-729.5; Fig. 11a-b) fall between ca. 5730 and 5470 cal BC, which is consistent with the late Starčevo-Criş dating of F21 based on pottery typology. The fact that the individual 2σ (95.4%) calibrated age ranges of the two herbivore bones do not overlap suggests they were not contemporaneous and, by extension, that the archaeological finds recovered from F21 do not represent a single, short-lived occupation event.

Burial M1 was dated stratigraphically to the Early Neolithic based on the fact that it was overlain (and perhaps 'sealed') by a deposit containing abundant Starčevo-Criş pottery sherds. The ^{14}C date (Table 2, RoAMS-729.7; Fig. 11c) obtained on compact bone from an ulna of skeleton M1 has a 2σ calibrated age range of ca. 5520–5330 cal BC. This range overlaps with that of RoAMS-729.5 but is broader (ca. 210 yr *vs* ca. 150 yr) because the ^{14}C age falls within a well-marked 'plateau' on the calibration curve (Fig. 11c) with a consequent reduction in dating precision.

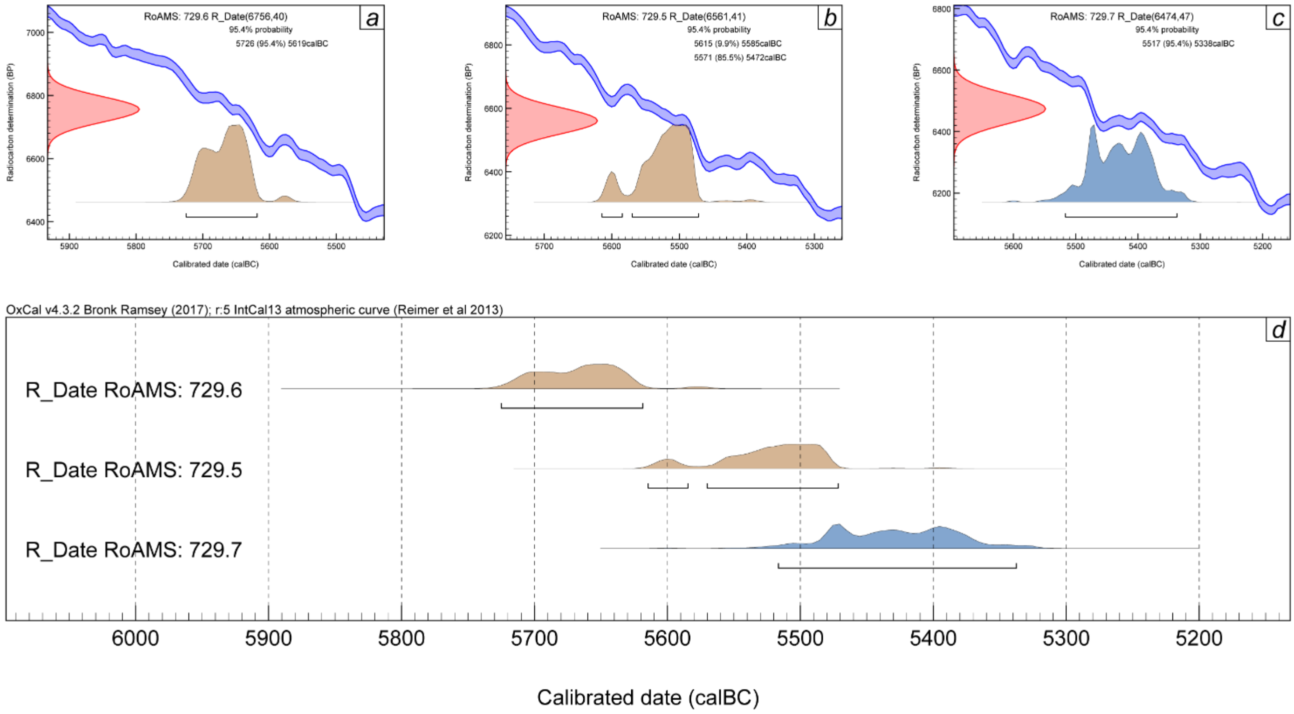

Figure 11. *Single plots (a–c) and a multiplot (d) of calibrated radiocarbon measurements on herbivore bone (brown) and human bone (blue) from Grumăzești – Deleni (cf. Table 2), generated in OxCal v 4.3.2.*

Although a date for M1 between 5520–5330 cal BC would accord with a late Starčevo-Criş context for the burial, the associated stable isotope data (Table 2) suggest the ^{14}C determination could be inaccurate. While the bone collagen $\delta^{13}C$ value of -20.0‰ is not inconsistent with a purely terrestrial diet, the $\delta^{15}N$ value of 11.1‰ is significantly higher than recorded among prehistoric farming populations in the central and northern Balkans whose dietary protein is likely to have come entirely or almost entirely from terrestrial sources (Table 3). In fact, the $\delta^{15}N$ value of M1 falls within the range of variation of individuals from Velesnica in the Iron Gates where the archaeofaunal record and organic residues in pottery sherds suggest the Early Neolithic economy was based on a combination of farming and fishing (Bonsall *et alii* 2015; Cramp *et alii* 2019). It is also worth noting that a detailed stable isotope study of LBK populations in Central Europe linked similarly elevated $\delta^{15}N$ values with mixed terrestrial and aquatic diets (Bickle 2018).

					δ¹³C			**δ¹⁵N**			
Site	**Location**	**Period**	***N* (adults)**	**Diet**	**low**	**high**	**μ/σ**	**low**	**high**	**μ/σ**	**Source**
Sarata Monteoru	Romania	BA	26	T	−20.0	−19.0	**−19.5 ±0.3**	8.0	10.4	**8.9 ±0.6**	Aguraiuja *et alii* 2018
Cârlomăneşti	Romania	BA	5	T	−19.6	−19.3	**−19.4 ±0.1**	9.7	10.2	**9.9 ±0.2**	Aguraiuja *et alii* 2018
Zemunica	Croatia	EN	10	T	−20.1	−19.7	**−20.0 ±0.1**	7.8	9.3	**8.4 ±0.6**	Guiry *et alii* 2017
Ajdovska Jama	Slovenia	LN	5	T	−20.6	−20.1	**−20.4 ±0.2**	8.1	9.0	**8.3 ±0.4**	Bonsall *et alii* 2007
Velesnica	Serbia	EN	3	AT	−19.4	−19.2	**−19.3 ±0.1**	10.6	11.7	**11.0 ±0.6**	Bonsall *et alii* 2015
Grumăzeşti – *Deleni*	Romania	EN	1	AT?			**−20.0**			**11.1**	

Abbreviations: EN – Early Neolithic, LN – Late Neolithic, BA – Bronze Age, T – terrestrial; AT – mixed terrestrial-aquatic.

Table 3. *Comparison of adult human bone collagen $\delta^{13}C$ and $\delta^{15}N$ data from Grumăzești – Deleni and selected Neolithic and Bronze Age sites in the central and northern Balkans.*

The frequent inclusion of aquatic resources in diet can result in the accumulation of ^{14}C-depleted carbon in human bone collagen sufficient to affect radiocarbon dates – known as a *reservoir effect* – making them too old. A substantial freshwater reservoir effect has been documented in the bones of prehistoric people living along the River Danube (*e.g.* Cook *et alii* 2001). However, in other situations where regular freshwater fish consumption has been documented, the reservoir effect has been shown to be very small or non-existent (*e.g.* Svyatko *et alii* 2017; Dury *et alii* 2018).

If the elevated $\delta^{15}N$ value of individual M1 from Grumăzeşti – *Deleni* is related to the inclusion of aquatic protein in his diet, then several questions arise:

- Does the ^{14}C age obtained from his bone collagen include a reservoir offset?
- Was fish a regular part of the diet of the Early Neolithic community at Grumăzeşti – *Deleni*?
- Or was M1 an immigrant from another community where fish accounted for a proportion of the protein intake?

These are questions that on present evidence cannot be resolved, but the following points are worth noting:

1) Burial M1 is still likely to be older than 5300 cal BC (late Starčevo-Criş), given its apparent stratigraphic position relative to F6;
2) No fish or shellfish remains were recovered in the excavations at Grumăzeşti – *Deleni* – however, bone preservation was generally poor and sieving was not employed;
3) Although today there are a number of streams and small rivers close to Grumăzeşti – *Deleni*, the nearest body of freshwater capable of supporting a significant, year-round fishery is arguably the River Bistriţa, ca. 20 km to the east of the site;
4) Research suggests that the isotopic composition of collagen in cortical bone in the shaft of the femur reflects that of diet during the period of skeletal growth (*e.g.* Matsubayashi, Tayasu 2019). If the same applies to other appendicular long bones of the human skeleton, then the $\delta^{13}C$ and $\delta^{15}N$ values obtained from an ulna shaft of M1 may largely reflect his diet *during adolescence*, rather than adulthood.

CONCLUSIONS

Burials M1 and M2 from Grumăzeşti – *Deleni* contained skeletal remains from individuals of differing ages. Results of bioarchaeological analysis, radiocarbon dating and bone collagen stable C- and N-isotope analysis have provided information on the sex, age-at-death, diet and lifestyle of the individual from burial M1, the only articulated skeleton from the site, but have left questions of chronology and mobility unresolved. Further analyses could contribute to a more comprehensive 'osteobiography' of the individuals from contexts M1 and M2. Stable C- and N-isotope analyses of a tooth and rib from M1, when combined with the data already obtained from an ulna, would allow comparison of his diet during childhood, adolescence and adulthood, while aDNA analysis of his dental calculus has the potential to contribute additional information on behaviour, diet and disease.

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REFERENCES

Aguraiuja *et alii* 2018 – Ü. Aguraiuja, M. Constantinescu, A. Lamb, C. Bonsall, *Bronze Age subsistence strategies in the southeastern Carpathian Bend area, Romania: Results from stable isotope analyses*, JAS: Reports 17, 2018, p. 510–519.

Antoniu, Rosca-Gramatopol 1966 – S. Antoniu, M. E. Rosca-Gramatopol, *Studiul anthropologic al scheletelor din complexul mormintelor cu ocru de la Valea Lupului*, Analele Ştinţiifice ale Universităţii "Al. I. Cuza" din Iaşi (Serie Nouă), Secţiunea II, Tomul XII, Fasc. I, 1966, p. 49–66.

Bass 2005 – W. M. Bass, *Human osteology: a field guide and manual*, 5th Edition, Archaeological Society, Missouri, 2005.

Bickle 2018 – P. Bickle, *Stable isotopes and dynamic diets: the Mesolithic-Neolithic dietary transition in terrestrial Central Europe*, JAS: Reports 22, 2018, p. 444–451.

Bonsall *et alii* 2007 – C. Bonsall, M. Horvat, K. McSweeney, M. Masson, T. F. G. Higham, C. Pickard, G. T. Cook, *Chronological and dietary aspects of the human burials from Ajdovska Cave, Slovenia*, Radiocarbon 49, 2007, p. 727–740.

Bonsall *et alii* 2015 – C. Bonsall, R. Vasić, A. Boroneanț, M. Roksandic, A. Soficaru, K. McSweeney, A. Evatt, Ü. Aguraiuja, C. Pickard, V. Dimitrijević, T. Higham, D. Hamilton, G. Cook, *New AMS ^{14}C dates for human remains from Stone Age sites in the Iron Gates reach of the Danube, Southeast Europe*, Radiocarbon 57, 2015, 1, p. 33–46.

Boroneanț 2012 – A. Boroneanț, *The archaeological excavations at Grumăzești – Neamț County. Part 1 – refitting the puzzle*, SP 9, 2012, p. 25–47.

Boroneanţ *et alii* 2018 – A. Boroneanţ, V. Diaconu, C. Bonsall, *Obsidian finds from the Early Neolithic site at Grumăzești – Deleni (Neamț County)*, MCA 14, 2018, p. 25–31.

Brigand, Weller 2018 – R. Brigand, O. Weller, *Kernel density estimation and transition maps of Moldavian Neolithic and Eneolithic settlement*, Data in Brief 17, 2018, p. 452–458.

Bronk Ramsey 2017 – C. Bronk Ramsey, *Methods for summarizing radiocarbon datasets*, Radiocarbon 59, 2017, 2, p. 1809–1833.

Brothwell 1989 – D. Brothwell, *The relationship of tooth wear to aging* in: M. Y. İşcan (ed.), *Age Markers in the Human Skeleton*, Springfield, Illinois, 1989, p. 306–316.

Buckberry, Chamberlain 2002 – J. L. Buckberry, A. T. Chamberlain, *Age Estimation from the Auricular Surface of the Ilium: A Revised Method*, AJPA 119, 2002, p. 231–239.

Buikstra, Ubelaker1994 - J. E. Buikstra, D. H. Ubelaker, *Standards for Data Collection from Human Skeletal Remains: Proceedings of a Seminar at the Museum of Natural History, Organized by Jonathon*

Haas, Arkansas Archaeological Survey Research Series No. 44, Fayetteville, Arkansas, 1994.

Capasso *et alii* 1999 – L. Capasso, K. A. R. Kennedy, C. A. Wilczak, *Atlas of occupational markers on human remains*, Teramo, 1999.

Cook *et alii* 2001 – G. T. Cook, C. Bonsall, R. E. M. Hedges, K. McSweeney, V. Boroneanţ, P. B. Pettitt, *A freshwater diet-derived ^{14}C reservoir effect at the Stone Age sites in the Iron Gates Gorge*, Radiocarbon 43, 2001, p. 453–460.

Cramp *et alii* 2019 – L. J. E. Cramp, J. Ethier, D. Urem-Koutsou, C. Bonsall, D. Borić, A. Boroneanţ, R. P. Evershed, S. Perić, M. Roffet-Salque, H. L. Whelton, M. Ivanova, *Regional diversity in subsistence among early farmers in Southeast Europe revealed by archaeological organic residues*, Proceedings of the Royal Society B 286, 2019, p. 2018–2347. https://doi.org/10.1098/rspb.2018.2347

Diaconu 2012 – V. Diaconu, *Depresiunea Neamț. Contribuții arheologice*, Piatra Neamț, 2012.

Dury *et alii* 2018 – J. P. R. Dury, G. Eriksson, M. Fjellström, T. K. Wallerström, K. Lidén, *Consideration of freshwater and multiple marine reservoir effects: dating of individuals with mixed diets from northern Sweden*, Radiocarbon 60, 2018, 5, p. 1561–1585.

Fazekas, Kósa 1978 – I. Fazekas, F. Kósa, *Forensic Fetal Osteology*, Akadémiai Kiadó, Budapest, 1978.

Jeanty 1983 – P. Jeanty, *Fetal limb biometry. (Letter)*, Radiology 147, 1983, p. 601–602.

Guiry *et alii* 2017 – E. Guiry, I. Karavanić, R. Šošić Klindžić, S. Talamo, S. Radović, M. P. Richards, *Stable isotope palaeodietary and radiocarbon evidence from the Early Neolithic site of Zemunica, Dalmatia, Croatia*, EJA 20, 2017, 2, p. 235–256.

Haas 1959 – N. Haas, C.Maximilian, D. Nicolăescu-Plopşor, *Studiu antropologic asupra scheletului Neolitic de la Boian*, MCA 5, 1959, p. 131–142.

Hillson 2005 – S. Hillson, *Teeth*, 2nd edition, Cambridge Manuals in Archaeology, Cambridge, 2005.

Ion, Soficaru 2008 - A. Ion, A. Soficaru, *The Anthropological study of Neolithic graves from Sultana-Malul Roșu*, SP 5, 2008, p. 153–158.

Judd 2004 – M. A. Judd, *Trauma in the city of Kerma: ancient versus modern injury patterns*, IJO 14, 2004, p. 34–51.

Lovejoy *et alii* 1985 – C. O. Lovejoy, R. S. Meindl, T. R. Pryzbeck, R. P. Mensforth, *Chronological metamorphosis of the auricular surface of the ilium. A new method for the determination of adult skeletal age at death*, AJPA 68, 1985, p. 15–28.

Lovell 1997 – N. C. Lovell, *Trauma analysis in palaeopathology*, Yearbook of Physical Anthropology 40, 1997, p. 139–170.

Marinescu-Bîlcu 1975 – S. Marinescu-Bîlcu, *Asupra unor probleme ale culturii Criș*, SCIVA 26, 1975, 4, p. 487–506.

Marinescu-Bîlcu 1993 – S. Marinescu-Bîlcu, *Les Carpates Orientales et la Moldavie*, in: J. Koszlowski, P.-L. van Berg (eds.), *Atlas du Néolithique Européen*, vol. 1, *L'Europe Orientale*, ERAUL 46, Liège, 1993, p. 191–243.

Matsubayashi, Tayasu 2019 – J. Matsubayashi, I. Tayasu, *Collagen turnover and isotopic records in cortical bone*, JAS 106, 2019, p. 37–44.

Necrasov 1965 – O. Necrasov, *Nouvelles données anthropologiques concernant la population de la culture Néolithique Starcevo-Criş*, ARA 2, 1965, p. 9–17.

Necrasov 1985 - O. Necrasov, *Données anthropologiques concernant la population du complexe culturel Cucuteni-Ariuşd-Tripolié: phases Cucuteni et Ariuşd*, ARA 22, 1985, p. 17–23.

Necrasov 1988 – O. Necrasov, *Sur l'anthropologie de la population de la culture Criş de Roumanie (Néolithique Ancien, 5500–4200 avant N.È.)*, ARA 25, 1988, p. 3–10.

Necrasov, Cristescu 1967 – O. Necrasov, M. Cristescu, *Aspecte antropologice ale neoliticului şi eneoliticului românesc*, SCA 4, 1967, 2, p. 159–169.

Necrasov *et alii* 1965 – O. Necrasov, R. Kluger, M. Roşca, *Studiul anthropologic al scheletor Eneolitice de la 'Dealul Sofia' (Cernavoda)*, SCA 2, 1965, 2, p. 163–173.

Nicolăescu-Plopşor 1964 – D. Nicolăescu-Plopşor, *Studiu antropologic şi morfobiologic al scheletelor neolitice tîrzii descoperite la Tîrpeşti*, SCA 1, 1964, 2, p. 157–172.

Nicolăescu-Plopşor 1966 – D. Nicolăescu-Plopşor *Expertiza antropologică asupra unui craniu de copil descoperit la Gumelniţa în 1960*, SCA 17, 1966, 1, p. 109–112.

Ortner 2003 – D. J. Ortner, *Identification of Pathological Conditions in Human Skeletal Remains*, 2nd edition, San Diego, 2003.

Paul, Cristescu 1963 – I. Paul, M. Cristescu, *Ein Hockergrab der Bemalten Keramik bei Salzburg (Ocna Sibiului)*, Forschungen zur Volks- und Landeskunde 6, 1963, p. 128–137.

Phenice 1969 – T. W. Phenice, *A newly developed visual method of sexing the os pubis*, AJPA 30, 1969, p. 297–302.

Reimer *et alii* 2013 – P. J. Reimer, E. Bard, A. Bayliss, J. W. Beck, P. G. Blackwell, C. Bronk Ramsey, P. M. Grootes, T. P. Guilderson, H. Haflidason, I. Hajdas, C. Hatté, T. J. Heaton, D. L. Hoffmann, A. G. Hogg, K. A. Hughen, K. F. Kaiser, B. Kromer, S. W. Manning, M. Niu, E. W. Reimer, D. A. Richards, E. M. Scott, J. R. Southon, R. A. Staff, C. S. M. Turney, J. van der Plicht, *IntCal13 and Marine13 Radiocarbon Age Calibration Curves 0-50,000 Years cal BP*, Radiocarbon 55, 2013, 4, p. 1869–1887.

Russu, Mareş 1956 – I. Russu, V. Mareş, *Consideraţii antropologice asupra scheletului aparţinînd culturii Criş de la Sf.Gheorghe-Bedehaza*, MCA 2, 1956, p. 28–39.

Sava *et alii* 2019 – T. Sava, C. A. Simion, O. Gâza, I. M. Stanciu, D. G. Păceșilă, G. O. Sava, L. Wacker, B. Ștefan, V. D. Moșu, D. G. Ghiță, A. Vasiliu, *Status report on the Sample Preparation Laboratory for Radiocarbon Dating at the new Bucharest RoAMS Center*, Radiocarbon 61, 2019, 2, p. 649–658.

Sayle *et alii* 2013 – K. L. Sayle, G. T. Cook, P. L. Ascough, H. R. Hastie, A. Einarsson, T. H. McGovern, M. T. Hicks, A. Edwald, A. Friðriksson, *Application of ^{34}S analysis for elucidating terrestrial, marine and freshwater ecosystems: evidence of animal movement/husbandry practices in an early Viking community around Lake Mývatn, Iceland*, Geochimica et Cosmochimica Acta 120, 2013, p. 531–544.

Schaefer *et alii* 2009 – M. Schaefer, S. Black, L. Scheuer, *Juvenile Osteology: A Laboratory and Field Manual*, Elsevier Academic Press, 2009.

Scheuer *et alii* 1980 – J. L. Scheuer, J. H. Musgrave, S. P. Evans, *The estimation of late fetal and perinatal age from limb bone length by linear and logarithmic regression*, AHB 7, 1980, 3, p. 257–265.

Svyatko *et alii* 2017 – S. V. Svyatko, R. Schulting, A. Poliakov, N. Ogle, P. J. Reimer, *A lack of freshwater reservoir effects in human radiocarbon dates in the Eneolithic to Iron Age in the Minusinsk Basin*, AAS 9, 2017, p. 1379–1388.

Trotter, Gleser 1952 – M. Trotter, G. C. Gleser, *Estimation of stature from long bones of American Whites and Negroes*, AJPA 10, 1952, p. 463–514.

Walker 2005 – P. L. Walker, *Greater sciatic notch morphology: sex, age, and population differences*, AJPA 127, 2005, p. 385–391.

Wolski, Nicolăescu-Plopşor 1970 – W. Wolski, D. Nicolăescu-Plopşor, *Consideraţii pe marginea unui mormînt dublu de înhumaţie descoperit în comuna Fărcaşele, Judeţul Olt*, SCA 7, 1970, 1, p. 3–11.